APPENDIX B: SAMPLE CALCULATIONS

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USEPA Method 5/29 (FPM/Metals)
Sampling, Velocity and Moisture Sample Calculations

Sample data taken from Run 1

Note: The tables presenting the results are generated electronically from raw data. It may not be possible to exactly duplicate these results using a calculator. The reference method data, results, and all calculations are carried to sixteen decimal places throughout. The final table is formatted to an appropriate number of significant figures.

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1. Volume of water collected (wscf)

$$V_{wstd} = (0.04706)(V_{lc})$$

Where:

V_{lc}	= total volume of liquid collected in impingers and silica gel (ml)	=	60.0	ml
0.04706	= ideal gas conversion factor (ft^3 water vapor/ml or gm)	=	0.04706	ft^3/ml
V_{wstd}	= volume of water vapor collected at standard conditions (ft^3)	=	2.82	ft^3

2. Volume of gas metered, standard conditions (dscf)

$$V_{mstd} = \frac{(17.64)(V_m)\left(P_{bar} + \frac{\Delta H}{13.6}\right)(Y_d)}{(460 + T_m)}$$

Where:

P_{bar}	= barometric pressure (in. Hg)	=	29.67	in. Hg
T_m	= average dry gas meter temperature (°F)	=	80.29	°F
V_m	= volume of gas sample through the dry gas meter at meter conditions (dcf)	=	34.48	dcf
Y_d	= gas meter correction factor (dimensionless)	=	0.9946	
ΔH	= average pressure drop across meter box orifice (in. H_2O)	=	0.97	in. H_2O
17.64	= standard temperature to pressure ratio (°R/in. Hg)	=	17.64	°R/in. Hg
13.6	= conversion factor (in. H_2O/in. Hg)	=	13.6	in.H_2O/in. Hg
460	= °F to °R conversion constant	=	460	
V_{mstd}	= volume of gas sampled through the dry gas meter at standard conditions (dscf)	=	33.300	dscf

3. Sample gas pressure (in. Hg)

$$P_s = P_{bar} + \left(\frac{P_g}{13.6}\right)$$

Where:

P_{bar}	= barometric pressure (in. Hg)	=	29.67	in. Hg
P_g	= sample gas static pressure (in. H_2O)	=	-1.40	in. H_2O
13.6	= conversion factor (in. H_2O/in. Hg)	=	13.6	in. H_2O/in. Hg
P_s	= absolute sample gas pressure (in. Hg)	=	29.57	in. Hg

4. Actual water vapor pressure at sample gas temperature less than 212°F (in. Hg)

$$P_v = \frac{e^{\left(18.3036 - \frac{3816.44}{\frac{5}{9}(T_s - 32) + 273.15 - 46.13}\right)}}{25.4}$$

Where:

T_s	= average sample gas temperature (°F)	=	104.00	°F
18.3036	= Antoine coefficient	=	18.3036	°K
3816.44	= Antoine coefficient	=	3816.44	°K
273.15	= temperature conversion factor	=	273.15	°K
46.13	= Antoine coefficient	=	46.13	°K
25.4	= conversion factor	=	25.4	mm Hg/in. Hg
5/9	= Fahrenheit to Celsius conversion factor	=	5/9	°C/°F
32	= temperature conversion (°F)	=	32	°F
P_v	= vapor pressure, actual (in. Hg)	=	2.17	in. Hg

5. Water vapor pressure at gas temperature greater than 212°F (in. Hg)

$$P_v = P_s$$

Where:

P_s	= absolute sample gas pressure (in. Hg)	=	29.57	in. Hg
P_v	= water vapor pressure, actual (in. Hg)	=	Previously Defined	in. Hg

6. Moisture measured in sample (% by volume)

$$B_{wo} = \frac{V_{wstd}}{(V_{mstd} + V_{wstd})}$$

Where:

V_{mstd}	= volume of gas sampled through the dry gas meter at standard conditions (dscf)	=	33.300	dscf
V_{wstd}	= volume of water collected at standard conditions (scf)	=	2.82	scf
B_{wo}	= proportion of water measured in the gas stream by volume	=	0.0782	
		=	7.82	%

7. Saturated moisture content (% by volume)

$$B_{ws} = \frac{P_v}{P_s}$$

Where:

P_s	= absolute sample gas pressure (in. Hg)	=	29.57	in. Hg
P_v	= water vapor pressure, actual (in. Hg)	=	2.17	in. Hg
B_{ws}	= proportion of water vapor in the gas stream by volume at saturated conditions		0.0735	
		=	7.35	%

8. Actual water vapor in gas (% by volume)

$$B_w = MINIMUM \quad [B_{wo}, B_{ws}]$$

Where:

B_{ws}	= proportion of water vapor in the gas stream by volume at saturated conditions	=	0.0735	
B_{wo}	= proportion of water measured in the gas stream by volume	=	0.0782	
B_w	= actual water vapor in gas	=	0.0735	
		=	7.35	%

9. Nitrogen (plus carbon monoxide) in gas stream (% by volume, dry)

$$N_2 + CO = 100 - CO_2 - O_2$$

Where:

CO_2	= proportion of carbon dioxide in the gas stream by volume (%)	=	0.1	%
O_2	= proportion of oxygen in the gas stream by volume (%)	=	21.0	%
100	= conversion factor (%)	=	100	%
N_2+CO	= proportion of nitrogen and CO in the gas stream by volume (%)	=	78.96	%

10. Molecular weight of dry gas stream (lb/lb·mole)

$$M_d = (M_{CO_2})\frac{(CO_2)}{(100)} + (M_{O_2})\frac{(O_2)}{(100)} + (M_{N_2+CO})\frac{(N_2+CO)}{(100)}$$

Where:

M_{CO2}	= molecular weight of carbon dioxide (lb/lb·mole)	=	44.00	lb/lb·mole
M_{O2}	= molecular weight of oxygen (lb/lb·mole)	=	32.00	lb/lb·mole
M_{N2+CO}	= molecular weight of nitrogen and carbon monoxide (lb/lb·mole)	=	28.00	lb/lb·mole
CO_2	= proportion of carbon dioxide in the gas stream by volume (%)	=	0.1	%
O_2	= proportion of oxygen in the gas stream by volume (%)	=	21.0	%
N_2+CO	= proportion of nitrogen and CO in the gas stream by volume (%)	=	79.0	%
100	= conversion factor (%)	=	100	%
M_d	= dry molecular weight of sample gas (lb/lb·mole)	=	28.85	lb/lb·mole

11. Molecular weight of sample gas (lb/lb·mole)

$$M_s = (M_d)(1 - B_w) + (M_{H_2O})(B_w)$$

Where:

B_w	= proportion of water vapor in the gas stream by volume	=	0.0735	
M_d	= dry molecular weight of sample gas (lb/lb·mole)	=	28.85	lb/lb·mole
M_{H2O}	= molecular weight of water (lb/lb·mole)	=	18.00	lb/lb·mole
M_s	= molecular weight of sample gas, wet basis (lb/lb·mole)	=	28.05	lb/lb·mole

12. Velocity of sample gas (ft/sec)

$$V_s = (K_p)(C_P)\left(\sqrt{\Delta P}\right)\left(\sqrt{\frac{(T_s + 460)}{(M_s)(P_s)}}\right)$$

Where:

K_p	= velocity pressure constant	=	85.49	
C_p	= pitot tube coefficient	=	0.84	
M_s	= wet molecular weight of sample gas, wet basis (lb/lb·mole)	=	28.05	lb/lb·mole
P_s	= absolute sample gas pressure (in. Hg)	=	29.57	in. Hg
T_s	= average sample gas temperature (°F)	=	104.00	°F
$\sqrt{\Delta P}$	= average square roots of velocity heads of sample gas (in. H_2O)	=	0.815	$\sqrt{\text{in. } H_2O}$
460	= °F to °R conversion constant	=	460	
V_s	= sample gas velocity (ft/sec)	=	48.26	ft/sec

13. Volumetric flow rate of sample gas at actual gas conditions (acfm)

$$Q_a = (60)(A_s)(V_s)$$

Where:

A_s	= cross sectional area of sampling location (ft^2)	=	4.59	ft^2
V_s	= sample gas velocity (ft/sec)	=	48.26	ft/sec
60	conversion factor (sec/min)	=	60	sec/min
Q_a	= volumetric flow rate at actual conditions (acfm)	=	13,281	acfm

14. Total flow of sample gas (scfm)

$$Q_s = (Q_a)\left(\frac{P_s}{29.92}\right)\left(\frac{68+460}{T_s+460}\right)$$

Where:

Q_a	= volumetric flow rate at actual conditions (acfm)	=	13,281	acfm
P_s	= absolute sample gas pressure (in. Hg)	=	29.57	in. Hg
29.92	= standard pressure (in. Hg)	=	29.92	in. Hg
T_s	= average sample gas temperature (°F)	=	104.0	°F
68	= standard temperature (°F)	=	68	°F
460	= °F to °R conversion constant	=	460	
Q_s	= volumetric flow rate at standard conditions, wet basis (scfm)	=	12,286	scfm

15. Dry flow of sample gas (dscfm)

$$Q_{std} = (Q_s)(1 - B_w)$$

Where:

B_w	= proportion of water vapor in the gas stream by volume	=	0.0735	
Q_s	= volumetric flow rate at standard conditions, wet basis (scfm)	=	12,286	scfm
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	=	11,383	dscfm

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16. Dry flow of sample gas corrected to 7%O_2 (dscfm)

$$Q_{std\,7} = (Q_{std})\left(\frac{20.9 - O_2}{20.9 - 7}\right)$$

Where:

Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	=	11,383	dscfm
O_2	= proportion of oxygen in the gas stream by volume (%)	=	21.0	%
20.9	= oxygen content of ambient air (%)	=	20.9	%
7	= oxygen content of corrected gas (%)	=	7.0	%
Q_{std7}	= volumetric flow rate at STP and 7%O_2, dry basis (dscfm)	=	(52)	dscfm

17. Hourly time basis conversion of volumetric flow rate (Q_{std} example)

$$Q_{std-hr} = (Q_{std-\min})(60)$$

Where

$Q_{std-min}$	= volumetric flow rate, english units (ft^3/min)	=	11,383	dscfm
60	= conversion factor (min/hr)	=	60	min/hr
Q_{std-hr}	= volumetric flow rate, hourly basis (dscf/hr)	=	682,995	dscf/hr

18. Metric Conversion of Gas Volumes (Q_{std} example)

$$Q_{std-metric} = (Q_{std-english})\left(\frac{60}{35.31}\right)$$

Where:

$Q_{std-english}$	= volumetric flow rate, english units (ft^3/min)	=	11,383	dscfm
35.31	= conversion factor (ft^3/m^3)	=	35.31	ft^3/m^3
60	= conversion factor (min/hr)	=	60	min/hr
$Q_{std-metric}$	= volumetric flow rate, metric units (m^3/hr)	=	19,343	dry std m^3/hr

19. Standard to Normal Conversion of Gas Volumes (Q_{std} example)

$$Q_{Normal} = (Q_{std-metric})\left(\frac{32 + 460}{68 + 460}\right)$$

Where:

$Q_{std-metric}$	= volumetric flow rate, metric units (dry std m^3/hr)	=	19,343	dry std m^3/hr
32	= normal temperature (°F)	=	32	°F
68	standard temperature (°F)	=	68	°F
460	= standard temperature in Rankine (68°F)	=	460	
Q_{Normal}	= volumetric flow rate, metric units (dry Nm^3/hr)	=	18,024	dry Nm^3/hr

20. Percent isokinetic (%)

$$I = \frac{(0.09450)(\overline{T_s} + 460)(V_{mstd})}{(P_s)(V_s)\left(\frac{(D_n)^2(\pi)}{(144)(4)}\right)(\Theta)(1 - B_w)}$$

Where:

D_n	= diameter of nozzle (in)	=	0.200	in.
B_w	= proportion of water vapor in the gas stream by volume	=	0.0735	
P_s	= absolute sample gas pressure (in. Hg)	=	29.57	in. Hg
T_s	= average sample gas temperature (°F)	=	104.0	°F
V_{mstd}	= volume of gas sample through the dry gas meter at standard conditions (dscf)	=	33.300	dscf
V_s	= sample gas velocity (ft/sec)	=	48.26	ft/sec
θ	= total sampling time (min)	=	60	min
0.0945	= conversion constant	=	0.0945	
460	= °F to °R conversion constant	=	460	
I	= percent of isokinetic sampling (%)	=	102.57	%

21. Alternative Method 5 Post-Test Meter Calibration Factor

$$Y_{qa} = \frac{\Theta}{V_m}\sqrt{\frac{(0.0319)(T_m + 460)(28.96)}{(\Delta H_@)(P_{bar} + \frac{\Delta H}{13.6})(M_d)}}\,(\sqrt{\Delta H})_{avg}$$

Where:

θ	= total sampling time (min)	=	60	min
V_m	= volume of gas sample through the dry gas meter at meter conditions (dcf)	=	34.48	dcf
T_m	= average dry gas meter temperature (°F)	=	80.29	°F
$\Delta H_@$	= dry gas meter orifice coefficient	=	1.7216	
P_{bar}	= barometric pressure (in. Hg)	=	29.67	in. Hg
ΔH	= average pressure drop across meter box orifice (in. H_2O)	=	0.971	in. H_2O
M_d	= dry molecular weight of sample gas (lb/lb·mole)	=	28.85	lb/lb·mole
$\sqrt{\Delta H}_{avg}$	= average of square root of pressure drop across meter orifice	=	0.971	√in. H_2O
0.0319	= conversion constant	=	0.0319	
28.96	= molecular weight of ambient air (lb/lb-mole)	=	28.96	lb/lb-mole
13.6	= conversion factor (in. H_2O/in. Hg)	=	13.6	in.H_2O/in. Hg
460	= °F to °R conversion constant	=	460	
Y_{qa}	= alternative Method 5 post-test meter calibration factor	=	0.9825	

USEPA Method 5 (FPM)
Sample Laboratory Analysis Calculations for FPM

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1. Residue mass of filter used in calculation

$$m_{fi-calc} = m_{fi} \quad \text{if } m_{fi} \geq MDL_f$$
$$m_{fi-calc} = (MDL_f)(F_r) \quad \text{if } m_{fi} < MDL_f$$

Where:

m_{f1}	= reported mass of filter "1" from gravimetric analysis (g)	=	0.01240	g
m_{f2}	= reported mass of filter "2" from gravimetric analysis (g)	=		g
m_{f3}	= reported mass of filter "3" from gravimetric analysis (g)	=		g
m_{f4}	= reported mass of filter "4" from gravimetric analysis (g)	=		g
MDL_f	= reported minimum gravimetric detection limit for filter fraction (g)	=	0.00010	g
F_r	= fraction of MDL applied to non-detectable run sample (g)	=	0.00	
$m_{f1-calc}$	= residue mass of filter "1" used in calculation (g)	=	0.01240	g
$m_{f2-calc}$	= residue mass of filter "2" used in calculation (g)	=		g
$m_{f3-calc}$	= residue mass of filter "3" used in calculation (g)	=		g
$m_{f4-calc}$	= residue mass of filter "4" used in calculation (g)	=		g

2. Total filter residue (g)

$$m_{filter} = \sum_{i=1}^{n} m_{fi-calc}$$

Where:

$m_{f1-calc}$	= residue mass of filter "1" used in calculation (g)	=	0.01240	g
$m_{f2-calc}$	= residue mass of filter "2" used in calculation (g)	=		g
$m_{f3-calc}$	= residue mass of filter "3" used in calculation (g)	=		g
$m_{f4-calc}$	= residue mass of filter "4" used in calculation (g)	=		g
m_{filter}	= total particulate collected on filters (g)	=	0.01240	g

3. Aliquot residue mass of blank sample used in calculation (g)

$$r_{ai-blank-calc} = r_{ai-blank} \quad \text{if } r_{ai-blank} \geq MDL_s$$
$$r_{ai-blank-calc} = (MDL_s)(F_b) \quad \text{if } r_{ai-blank} < MDL_s$$

Where:

			Acetone	
$r_{ai-blank}$	= aliquot residue mass of blank sample for solvent "i" (g)	=	0.00060	g
MDL_s	= reported minimum gravimetric detection limit for solvent rinse (g)	=	0.00010	g
F_b	= fraction of MDL applied to non-detectable blank sample (g)	=	0.00	
$r_{ai-blank-calc}$	= aliquot residue mass of blank sample for solvent "i" used in calculation (g)	=	0.00060	g

4. Aliquot residue mass of run sample used in calculation (g)

$$r_{ai-calc} = r_{ai} \quad \text{if } r_{ai} \geq MDL_s$$
$$r_{ai-calc} = (MDL_s)(F_r) \quad \text{if } r_{ai} < MDL_s$$

Where:

			Acetone	
r_{ai}	= aliquot residue mass of run sample for solvent "i" (g)	=	0.00780	g
MDL_s	= reported minimum gravimetric detection limit for solvent rinse (g)	=	0.00010	g
F_r	= fraction of MDL applied to non-detectable run sample (g)	=	1.00	
$r_{ai-calc}$	= aliquot residue mass of run sample for solvent "i" used in calculation (g)	=	0.00780	g

5. Residue mass of run sample (g)

$$r_{si} = (r_{ai-calc})\left(\frac{v_{si}}{v_{ai}}\right)$$

Where:			Acetone	
$r_{ai-calc}$	= aliquot residue mass of run sample for solvent "i" used in calculation (g)	=	0.00780	g
v_{si}	= liquid volume of run sample for solvent rinse "i" (mL)	=	136	mL
v_{ai}	= aliquot volume use for solvent rinse "i" (mL) used in gravimetric analysis (mL)	=	136	mL
r_{si}	= residue mass of run sample for solvent rinse "i" (g)	=	0.00780	g

6. Maximum allowable blank correction for solvent rinse (g)

$$m_{bi} = MINIMUM\left[\left(\frac{(r_{ai-blank-calc})(v_{si})}{v_{ai-blank}}\right) \quad or \quad (0.00001)(\rho_i)(v_{si}) \quad or \quad (r_{si})\right]$$

Where:			Acetone	
$r_{ai-blank-calc}$	= blank aliquot residue mass for solvent "i" used in calculation (g)	=	0.00060	g
v_{si}	= liquid volume of run sample for solvent rinse "i" (mL)	=	136.0	mL
$v_{ai-blank}$	= liquid volume of blank sample for solvent rinse "i" (mL)	=	218.0	mL
0.00001	= EPA M-5 fraction of total rinse that can be subtracted (g)	=	0.00001	
ρ_i	= density of solvent rinse "i" (g/mL)	=	0.7845	g/ml
r_{si}	= residue mass of run sample for solvent rinse "i" (g)	=	0.00780	g
m_{bi}	= maximum allowable blank correction for solvent rinse "i" (g)	=	0.00037	g

The first part of the expression is used for solvent rinse 1; the blank is the concentration of the blank, times the size of the sample

7. Net residue mass of run sample (g)

$$m_i = (r_{si} - m_{bi})$$

Where:			Acetone	
r_{si}	= residue mass of run sample for solvent rinse "i" (g)	=	0.00780	g
m_{bi}	= maximum allowable blank correction for solvent rinse "i" (g)	=	0.00037	g
m_i	= net residue mass of run sample for solvent rinse "i" (g)	=	0.00743	g

8. Total solvent residue - (g)

$$m_s = \sum_{i=1}^{n} m_i$$

Where:				
m_1	= net residue mass of solvent rinse "1" (g)	=	0.00743	g
m_2	= net residue mass of solvent rinse "2" (g)	=	N/A	g
m_3	= net residue mass of solvent rinse "3" (g)	=	N/A	g
m_s	= total solvent residue (g)	=	0.00743	g

9. Total gravimetric result (g)

$$m_T = m_{filter} + m_s$$

Where:				
m_{filter}	= total particulate collected on filters (g)	=	0.01240	g
m_s	= total solvent residue (g)	=	0.00743	g
m_T	= total gravimetric result (g)	=	0.01983	g

10. Total gravimetric detection limit (g)

$$m_D = (MDL_f)(n_f) + (MDL_s)(n_s)$$

Where:

MDL_f	= reported minimum gravimetric detection limit for filter fraction (g)	=	0.00010	g
n_f	= number of filters in analysis	=	1	
MDL_s	= reported minimum gravimetric detection limit for solvent rinse (g)	=	0.00010	g
n_s	= number of solvent rinses in analysis	=	1	
m_D	= total gravimetric detection limit (g)	=	0.00020	g

11. Total filterable particulate matter (g)

$$m_n = MAXIMUM[m_T \quad or \quad m_D]$$

Where:

m_T	= total gravimetric result (g)	=	0.01983	g
m_D	= total gravimetric detection limit (g)	=	0.00020	g
m_n	= total filterable particulate matter (g)	=	0.01983	g

USEPA Method 5 (FPM)
Sample Emission Calculations for FPM

Sample data taken from Run 1

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1. Filterable particulate matter concentration (lb/dscf)

$$C_{sd} = \left(\frac{m_n}{V_{mstd}}\right)\left(2.205\times10^{-3}\right)$$

Where:

m_n	= total filterable particulate matter (g)	=	0.01983	g
V_{mstd}	= volume metered, standard (dscf)	=	33.3002	dscf
2.205×10^{-3}	= conversion factor (lb/g)	=	2.205E-03	lb/g
C_{sd}	= filterable particulate matter concentration (lb/dscf)	=	1.3128E-06	lb/dscf

2. Filterable particulate matter concentration (gr/dscf)

$$C_{sd} = \left(\frac{m_n}{V_{mstd}}\right)(15.43)$$

Where:

m_n	= total filterable particulate matter (g)	=	0.01983	g
V_{mstd}	= volume metered, standard (dscf)	=	33.3002	dscf
15.43	= conversion factor (gr/g)	=	15.43	gr/g
C_{sd}	= filterable particulate matter concentration (gr/dscf)	=	0.0092	gr/dscf

3. Filterable particulate matter concentration (mg/dscm)

$$C_{sd} = \left(\frac{m_n}{V_{mstd}}\right)(1000)(35.31)$$

Where:

m_n	= total filterable particulate matter (g)	=	0.01983	g
V_{mstd}	= volume metered, standard (dscf)	=	33.3002	dscf
1000	= conversion factor (mg/g)	=	1000	mg/g
35.31	= conversion factor (dscf/dscm)	=	35.31	dscf/dscm
C_{sd}	= filterable particulate matter concentration (mg/dscm)	=	21.0222	mg/dscm

4. Filterable particulate matter concentration (mg/Nm3 dry)

$$C_{sd} = \left(\frac{m_n}{V_{mstd}}\right)(1000)(35.31)\left(\frac{68+460}{32+460}\right)$$

Where:

m_n	= total filterable particulate matter (g)	=	0.01983	g
V_{mstd}	= volume metered, standard (dscf)	=	33.3002	dscf
1000	= conversion factor (mg/g)	=	1000	mg/g
35.31	= conversion factor (dscf/dscm)	=	35.31	dscf/dscm
68	= standard temperature (°F)	=	68	°F
32	= normal temperature (°F)	=	32	°F
460	= °F to °R conversion constant	=	460	
C_{sd}	= filterable particulate matter concentration (mg/Nm3 dry)	=	22.5604	mg/Nm^3 dry

5. Filterable particulate matter concentration at actual gas conditions (gr/acf example)

$$C_a = C_{sd}\left(\frac{Q_{std}}{Q_a}\right)$$

Where:

C_{sd}	= filterable particulate matter concentration (gr/dscf)	=	0.0092	gr/dscf
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	=	11,383	dscfm
Q_a	= volumetric flow rate at actual conditions (acfm)	=	13,281	acfm
C_a	= filterable particulate matter concentration at actual gas conditions (gr/acf)	=	0.0079	gr/acf

6. Filterable particulate matter rate (lb/hr)

$$E_{lb/hr} = \left(\frac{m_n}{V_{mstd}}\right)\left(2.205\times10^{-3}\right)\left(Q_{std}\right)(60)$$

Where:

m_n	= total filterable particulate matter (g)	=	0.01983	g
V_{mstd}	= volume metered, standard (dscf)	=	33.3002	dscf
2.205×10^{-3}	= conversion factor (lb/g)	=	2.205E-03	lb/g
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	=	11,383	dscfm
60	= conversion factor (min/hr)	=	60	min/hr
$E_{lb/hr}$	= filterable particulate matter rate (lb/hr)	=	0.8966	lb/hr

7. Filterable particulate matter rate (kg/hr)

$$E_{kg/hr} = \left(\frac{m_n}{V_{mstd}}\right)\left(\frac{\left(Q_{std}\right)(60)}{1000}\right)$$

Where:

m_n	= total filterable particulate matter (g)	=	0.01983	g
V_{mstd}	= volume metered, standard (dscf)	=	33.3002	dscf
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	=	11,383	dscfm
60	= conversion factor (min/hr)	=	60	min/hr
1000	= conversion factor (g/kg)	=	1000	g/kg
$E_{kg/hr}$	= filterable particulate matter rate (kg/hr)	=	0.4066	kg/hr

8. Filterable particulate matter rate - Production-based (lb/tons of feed)

$$E_{Rp} = \left(\frac{m_n}{V_{mstd}}\right)\left(2.205\times10^{-3}\right)\left(\frac{(Q_{std})(60)}{R_p}\right)$$

Where:

m_n	= total filterable particulate matter (g)	=	0.01983	g
V_{mstd}	= volume metered, standard (dscf)	=	33.3002	dscf
2.205×10^{-3}	= conversion factor (lb/g)	=	2.205E-03	lb/g
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	=	11,383	dscfm
60	= conversion factor (min/hr)	=	60	min/hr
R_p	= production rate (tons of feed/hr)	=	323	tons of feed/hr
E_{Rp}	= filterable particulate matter rate - production-based (lb/tons of feed)	=	0.00278	lb/tons of feed

9. Filterable particulate matter rate - Production-based (kg/tons of feed)

$$E_{Rp} = \left(\frac{m_n}{V_{mstd}}\right)\left(\frac{(Q_{std})(60)}{(1000)(R_p)}\right)$$

Where:

m_n	= total filterable particulate matter (g)	=	0.01983	g
V_{mstd}	= volume metered, standard (dscf)	=	33.3002	dscf
1000	= conversion factor (g/kg)	=	1000	g/kg
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	=	11,383	dscfm
60	= conversion factor (min/hr)	=	60	min/hr
R_p	= production rate (tons of feed/hr)	=	323	tons of feed/hr
E_{Rp}	= filterable particulate matter rate - production-based (kg/tons of feed)	=	0.00126	kg/tons of feed

LOGIC FOR TREATING DETECTION LIMITS

(mercury only)

1. Logic for Determining Total Blank ($m_{Total-B}$) from 5 Fractions

Rule	CASE 1 All 5 fractions are D.	CASE 2 1 to 4 fractions are ND	CASE 3 All 5 fractions are ND
ND = 0	$m_{Total-B}$ = Sum D, 1-5	$m_{Total-B}$ = Sum D	$m_{Total-B}$ = < Sum ND
ND=1x	$m_{Total-B}$ = Sum D, 1-5	$m_{Total-B}$ = Sum D	$m_{Total-B}$ = < Sum ND
ND=0.5x	$m_{Total-B}$ = Sum D, 1-5	$m_{Total-B}$ = Sum D	$m_{Total-B}$ = < 0.5 Sum ND

2. Logic for Determining Total Sample ($m_{Total-S}$) from 5 Fractions

Rule	CASE 1 All 5 fractions are D.	CASE 2 1 to 4 fractions are ND	CASE 3 All 5 fractions are ND
ND = 0	$m_{Total-S}$ = Sum D, 1-5	$m_{Total-S}$ = Sum D	$m_{Total-S}$ = < Sum ND
ND=1x	$m_{Total-S}$ = Sum D, 1-5	$m_{Total-S}$ = < [Sum D + Sum ND]	$m_{Total-S}$ = < Sum ND
ND=0.5x	$m_{Total-S}$ = Sum D, 1-5	$m_{Total-S}$ = < [SumD+0.5 SumND	$m_{Total-S}$ = < 0.5 Sum ND

3. Logic for Determining Maximum Allowable Blank Correction ($m_{T-B-allow}$)

Rule	CASE 1 All 5 fractions are D. $m_{Total-B}$ = D	CASE 2 1 to 4 sample fractions are ND $m_{Total-B}$ = D	CASE 3 All 5 fractions are ND $m_{Total-B}$ = D	CASE 4 Any type of fractions $m_{Total-B}$ = ND
ND = 0	$m_{T-B-allow}$ = M29 Rule	$m_{T-B-allow}$ = M29 Rule*	$m_{T-B-allow}$ = 0	$m_{T-B-allow}$ = 0
ND=1x	$m_{T-B-allow}$ = M29 Rule	$m_{T-B-allow}$ = M29 Rule*	$m_{T-B-allow}$ = 0	$m_{T-B-allow}$ = 0
ND=0.5x	$m_{T-B-allow}$ = M29 Rule	$m_{T-B-allow}$ = M29 Rule*	$m_{T-B-allow}$ = 0	$m_{T-B-allow}$ = 0

* M29 rule using only detected sample quantities for logical comparisons.

4. Logic for Determining Blank-Corrected Sample Amount (m_n)

Rule	CASE 1 All 5 fractions are D. $m_{Total-S} - m_{T-B-allow} \geq$ MIN(MDL)	CASE 2 1 to 4 sample fractions are ND $m_{Total-S} - m_{T-B-allow} \geq$ MIN(MDL)	CASE 3 All 5 fractions are ND $m_{Total-S}$ and $m_{T-B-allow}$ anything	CASE 4 Any type of fractions $m_{Total-S} - m_{T-B-allow}$ < MIN(MDL)
ND = 0	$m_n = m_{Total-S} - m_{T-B-allow}$	$m_n = m_{Total-S} - m_{T-B-allow}$	m_n = < $m_{Total-S}$	m_n = < MIN[MDL]
ND=1x	$m_n = m_{Total-S} - m_{T-B-allow}$	m_n = < [$m_{Total-S} - m_{T-B-allow}$]	m_n = < $m_{Total-S}$	m_n = < MIN[MDL]
ND=0.5x	$m_n = m_{Total-S} - m_{T-B-allow}$	m_n = < [$m_{Total-S} - m_{T-B-allow}$]	m_n = < $m_{Total-S}$	m_n = < MIN[MDL]

Definitions and Notes

The term "Rule" refers to the rule being implemented for handling non-detectable quantities in summations.
MDL = minimum detection limit.
D = Detectable quantity reported as D.
ND = Non-Detectable quantity reported at a value of ND.
MIN[MDL] = lowest quantity of all detection limits for 5 fractions.

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SS Metals-1 Version 2006-12c

USEPA Method 5/29 (FPM/Metals)
Mercury Analyte Calculations

Sample data taken from Run 1

Note: The tables presenting the results are generated electronically from raw data. It may not be possible to exactly duplicate these results using a calculator. The reference method data, results, and all calculations are carried to sixteen decimal places throughout. The final table is formatted to an appropriate number of significant figures.

Note: Please see the preceding page concerning treatment of minimum detection limits and mathematical operations on values that are below minimum detection limits.

101017 120221
P

1. Total blank amount (µg)

$$m_{total-B} = \sum_{i=1}^{n} m_{i-B}$$

Where:

$m_{1b\text{-}B}$	= mercury amount in blank for Fraction 1b	=	<0.1000	µg
$m_{2b\text{-}B}$	= mercury amount in blank for Fraction 2b	=	<0.2000	µg
$m_{3a\text{-}B}$	= mercury amount in blank for Fraction 3a	=	<0.2000	µg
$m_{3b\text{-}B}$	= mercury amount in blank for Fraction 3b	=	<0.5000	µg
$m_{3c\text{-}B}$	= mercury amount in blank for Fraction 3c	=	<0.4000	µg
$m_{total\text{-}B}$	= total amount of mercury in blank	=	<1.4000	µg

2. Total sample amount (µg)

$$m_{total-S} = \sum_{i=1}^{n} m_{i-S}$$

Where:

$m_{1b\text{-}S}$	= mercury amount in sample for Fraction 1b	=	<0.1000	µg
$m_{2b\text{-}S}$	= mercury amount in sample for Fraction 2b	=	<0.4000	µg
$m_{3a\text{-}S}$	= mercury amount in sample for Fraction 3a	=	<0.2000	µg
$m_{3b\text{-}S}$	= mercury amount in sample for Fraction 3b	=	11.4605	µg
$m_{3c\text{-}S}$	= mercury amount in sample for Fraction 3c	=	19.3802	µg
$m_{total\text{-}S}$	= total amount of mercury in sample	=	30.8407	µg

3. Allowable blank correction (µg)

$$m_{T-B-allow} = m_{total-B} \text{ if } m_{total-B} \leq 0.6$$
$$m_{T-B-allow} = MAX\left[0.6,\quad MIN\left(m_{total-B},\quad 0.05 \times m_{total-S}\right)\right] \text{ if } m_{total-B} > 0.6$$

Where:

$m_{total\text{-}B}$	= total amount of mercury in blank	=	<1.4000	µg
$m_{total\text{-}S}$	= total amount of mercury in sample	=	30.8407	µg
0.05 x $m_{total\text{-}S}$	= 5% of $m_{total\text{-}S}$	=	1.5420	µg
MAX	= arithmetic operator that returns the maximum of two values			
MIN	= arithmetic operator that returns the minimum of two values			
$m_{T\text{-}B\text{-}allow}$	= total allowable blank correction	=	0.0000	µg

NOTE: In this case, the second criteria applies.

4. Sample corrected for allowable blank - Total (µg)

$$m_n = m_{total-S} - m_{T-B-allow}$$

Where:

$m_{total-S}$	= total amount of mercury in sample	=	30.8407	µg
$m_{T-B-allow}$	= total allowable blank correction	=	0.0000	µg
m_n	= total mercury in sample corrected for allowable blank	=	30.8407	µg

5. Sample corrected for allowable blank - Prorated for each fraction (µg)

$$m_{n-i} = \left(\frac{m_{i-S}}{m_{total\text{-}S}}\right)(m_n)$$

Where:

m_n	= total mercury in sample corrected for allowable blank	=	30.8407	µg
m_{1b-S}	= mercury amount in sample for Fraction 1b	=	<0.1000	µg
m_{2b-S}	= mercury amount in sample for Fraction 2b	=	<0.4000	µg
m_{3a-S}	= mercury amount in sample for Fraction 3a	=	<0.2000	µg
m_{3b-S}	= mercury amount in sample for Fraction 3b	=	11.4605	µg
m_{3c-S}	= mercury amount in sample for Fraction 3c	=	19.3802	µg
$m_{total-S}$	= total amount of mercury in sample	=	30.8407	µg
m_{n-1b}	= mercury corrected for blank - prorated for Fraction 1b	=	<0.1000	µg
m_{n-2b}	= mercury corrected for blank - prorated for Fraction 2b	=	<0.4000	µg
m_{n-3a}	= mercury corrected for blank - prorated for Fraction 3a	=	<0.2000	µg
m_{n-3b}	= mercury corrected for blank - prorated for Fraction 3b	=	11.4605	µg
m_{n-3c}	= mercury corrected for blank - prorated for Fraction 3c	=	19.3802	µg

USEPA Method 5/29 (FPM/Metals)
Mercury Sample Calculations

Sample data taken from Run 1

Note: The tables presenting the results are generated electronically from raw data. It may not be possible to exactly duplicate these results using a calculator. The reference method data, results, and all calculations are carried to sixteen decimal places throughout. The final table is formatted to an appropriate number of significant figures.

101017 120449
P_P

1. Mercury concentration (lb/dscf)

$$C_{sd} = \left(\frac{m_n}{V_{mstd}}\right)\left(\frac{2.205\times10^{-3}}{10^6}\right)$$

Where:

m_n	= mercury collected in sample (total µg)	=	30.8407	µg
V_{mstd}	= volume metered, standard (dscf)	=	33.3002	dscf
2.205×10^{-3}	= conversion factor (lb/g)	=	2.205E-03	lb/g
10^6	= conversion factor (µg/g)	=	1.0E+06	µg/g
C_{sd}	= mercury concentration (lb/dscf)	=	2.0421E-09	lb/dscf

2. Mercury concentration (µg/dscm)

$$C_{sd} = \left(\frac{m_n}{V_{mstd}}\right)(35.31)$$

Where:

m_n	= mercury collected in sample (total µg)	=	30.8407	µg
V_{mstd}	= volume metered, standard (dscf)	=	33.3002	dscf
35.31	= conversion factor (dscf/dscm)	=	35.31	dscf/dscm
C_{sd}	= mercury concentration (µg/dscm)	=	3.2702E+01	µg/dscm

3. Mercury concentration (mg/dscm)

$$C_{sd} = \left(\frac{m_n}{V_{mstd}}\right)\left(\frac{35.31}{1000}\right)$$

Where:

m_n	= mercury collected in sample (total µg)	=	30.8407	µg
V_{mstd}	= volume metered, standard (dscf)	=	33.3002	dscf
35.31	= conversion factor (dscf/dscm)	=	35.31	dscf/dscm
1000	= conversion factor (µg/mg)	=	1000	µg/mg
C_{sd}	= mercury concentration (mg/dscm)	=	3.2702E-02	mg/dscm

4. Mercury concentration (µg/Nm3 dry)

$$C_{sd} = \left(\frac{m_n}{V_{mstd}}\right)(35.31)\left(\frac{68+460}{32+460}\right)$$

Where:

m_n	= mercury collected in sample (total µg)	=	30.8407	µg
V_{mstd}	= volume metered, standard (dscf)	=	33.3002	dscf
35.31	= conversion factor (dscf/dscm)	=	35.31	dscf/dscm
68	= standard temperature (°F)	=	68	°F
32	= normal temperature (°F)	=	32	°F
460	= °F to °R conversion constant	=	460	
C_{sd}	= mercury concentration (µg/Nm3 dry)	=	3.5095E+01	µg/Nm^3 dry

5. Mercury concentration at actual gas conditions (lb/acf example)

$$C_a = C_{sd}\left(\frac{Q_{std}}{Q_a}\right)$$

Where:

C_{sd}	= mercury concentration (lb/dscf)	=	2.0421E-09	lb/dscf
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	=	11,383	dscfm
Q_a	= volumetric flow rate at actual conditions (acfm)	=	13,281	acfm
C_a	= mercury concentration at actual gas conditions (lb/acf)	=	1.7504E-09	lb/acf

6. Mercury emission rate (lb/hr)

$$E_{lb/hr} = \left(\frac{m_n}{V_{mstd}}\right)\left(\frac{2.205\times10^{-3}}{10^6}\right)(Q_{std})(60)$$

Where:

m_n	= mercury collected in sample (total µg)	=	30.8407	µg
V_{mstd}	= volume metered, standard (dscf)	=	33.3002	dscf
2.205×10^{-3}	= conversion factor (lb/g)	=	2.205E-03	lb/g
10^6	= conversion factor (µg/g)	=	1.0E+06	µg/g
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	=	11,383	dscfm
60	= conversion factor (min/hr)	=	60	min/hr
$E_{lb/hr}$	= mercury emission rate (lb/hr)	=	1.3948E-03	lb/hr

7. Mercury emission rate (g/s)

$$E_{g/s} = \left(\frac{m_n}{V_{mstd}}\right)\left(\frac{Q_{std}}{(10^6)(60)}\right)$$

Where:

m_n	= mercury collected in sample (total µg)	=	30.8407	µg
V_{mstd}	= volume metered, standard (dscf)	=	33.3002	dscf
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	=	11,383	dscfm
10^6	= conversion factor (µg/g)	=	1.0E+06	µg/g
60	= conversion factor (sec/min)	=	60	sec/min
$E_{g/s}$	= mercury emission rate (g/s)	=	1.7571E-04	g/s

8. Mercury Emission Rate - Production-based (lb/unit)

$$E_{RP} = \left(\frac{m_n}{V_{mstd}}\right)\left(\frac{2.205\times10^{-3}}{10^6}\right)\left(\frac{(Q_{std})(60)}{R_p}\right)$$

Where:

m_n	= mercury collected in sample (total µg)	=	30.8407	µg
V_{mstd}	= volume metered, standard (dscf)	=	33.3002	dscf
2.205×10^{-3}	= conversion factor (lb/g)	=	2.205E-03	lb/g
10^6	= conversion factor (µg/g)	=	1.0E+06	µg/g
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	=	11,383	dscfm
60	= conversion factor (min/hr)	=	60	min/hr
R_p	= production rate (units/hr)	=	323	units/hour
E_{RP}	= mercury emission rate - production-based (lb/xxxxx)	=	4.3176E-06	lb/unit

9. Mercury Emission Rate - Production-based (g/unit)

$$E_{RP} = \left(\frac{m_n}{V_{mstd}}\right)\left(\frac{(Q_{std})(60)}{(10^6)(R_p)}\right)$$

Where:

m_n	= mercury collected in sample (total µg)	=	30.8407	µg
V_{mstd}	= volume metered, standard (dscf)	=	33.3002	dscf
10^6	= conversion factor (µg/g)	=	1.0E+06	µg/g
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	=	11,383	dscfm
60	= conversion factor (min/hr)	=	60	min/hr
R_p	= production rate (units/hr)	=	323	units/hour
E_{RP}	= mercury emission rate - production-based (g/xxxxx)	=	1.9581E-03	g/unit

LOGIC FOR TREATING DETECTION LIMITS

(all metals except mercury)

1. Logic for Determining Maximum Allowable Front-Half Blank Correction ($m_{FB\text{-}allow}$)

	CASE 1	**CASE 2**
	m_{FB} = D	m_{FB} = ND
Rule		
ND = 0	$m_{FB\text{-}allow}$ = M29 Rule	$m_{FB\text{-}allow} = 0$
ND=1x	$m_{FB\text{-}allow}$ = M29 Rule	$m_{FB\text{-}allow} = 0$
ND=0.5x	$m_{FB\text{-}allow}$ = M29 Rule	$m_{FB\text{-}allow} = 0$

2. Logic for Determining Blank-Corrected Front-Half Sample Amount (m_F)

	CASE 1	**CASE 2**
	$m_{FS} - m_{FB\text{-}allow} \geq$ MDL	$m_{FS} - m_{FB\text{-}allow} <$ MDL
Rule		
ND = 0	$m_F = m_{FS} - m_{FB\text{-}allow}$	m_F = < MDL
ND=1x	$m_F = m_{FS} - m_{FB\text{-}allow}$	m_F = < MDL
ND=0.5x	$m_F = m_{FS} - m_{FB\text{-}allow}$	m_F = < MDL

3. Logic for Determining Maximum Allowable Back-Half Blank Correction ($m_{BB\text{-}allow}$)

	CASE 1	**CASE 2**
	m_{BB} = D	m_{BB} = ND
Rule		
ND = 0	$m_{BB\text{-}allow}$ = M29 Rule	$m_{BB\text{-}allow} = 0$
ND=1x	$m_{BB\text{-}allow}$ = M29 Rule	$m_{BB\text{-}allow} = 0$
ND=0.5x	$m_{BB\text{-}allow}$ = M29 Rule	$m_{BB\text{-}allow} = 0$

4. Logic for Determining Blank-Corrected Back-Half Sample Amount (m_B)

	CASE 1	**CASE 2**
	$m_{BS} - m_{BB\text{-}allow} \geq$ MDL	$m_{BS} - m_{BB\text{-}allow} <$ MDL
Rule		
ND = 0	$m_B = m_{BS} - m_{BB\text{-}allow}$	m_B = < MDL
ND=1x	$m_B = m_{BS} - m_{BB\text{-}allow}$	m_B = < MDL
ND=0.5x	$m_B = m_{BS} - m_{BB\text{-}allow}$	m_B = < MDL

5. Logic for Adding Front and Back-Half Corrected Samples (m_n)

	CASE 1	**CASE 2**	**CASE 3**
	Both are D	One is D, other is ND	Both are ND
Rule			
ND = 0	$m_n = m_F + m_B$	m_n = D	m_n = < Sum ND
ND=1x	$m_n = m_F + m_B$	m_n = < [D + ND]	m_n = < Sum ND
ND=0.5x	$m_n = m_F + m_B$	m_n = <[D + 0.5ND]	m_n = < 0.5 Sum ND

<u>**Definitions and Notes**</u>

The term "Rule" refers to the rule being implemented for hanMDLing non-detectable quantities in summations
MDL = minimum detection limit.
D = Detectable quantity reported as D.
ND = Non-Detectable quantity reported at a value of ND.
If Front and Back-Half fractions are combined, then only Items 1 and 2 are used.

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USEPA Method 5/29 (FPM/Metals)
Phosphorus Analyte Calculations

Sample data taken from Run 1

Note: The tables presenting the results are generated electronically from raw data. It may not be possible to exactly duplicate these results using a calculator. The reference method data, results, and all calculations are carried to sixteen decimal places throughout. The final table is formatted to an appropriate number of significant figures.

Note: Please see the preceding page concerning treatment of minimum detection limits and mathematical operations on values that are below minimum detection limits.

101017 121303
M

1. Maximum front-half blank correction criteria (µg)

$$A = (1.4)\left(\frac{3.141593}{4}\right)\left(\frac{D}{2.54}\right)^2$$

Where:

D	= diameter of filter used in sample apparatus	=	8.2	cm
1.4	= allowable blank per square inch of filter area	=	1.4	µg/in^2
2.54	= conversion constant	=	2.54	cm/in
4	= conversion constant	=	4	
3.141593	= conversion constant (pi)	=	3.141593	
A	= maximum front-half blank correction criteria	=	12.46	µg

2. Allowable blank correction - combined front and back-half sample fractions (µg)

$$m_{FB-allow} = m_{FB} \text{ if } m_{FB} \leq A + 1$$

$$m_{FB-allow} = MAX\ [A + 1,\ \ MIN\ (m_{FB},\ \ 0.05 \times m_{FS})] \text{ if } m_{FB} > A + 1$$

Where:

m_{FB}	= phosphorus amount in combined front- and back-half blank	=	20.2065	µg
m_{FS}	= phosphorus amount in combined front- and back-half sample	=	46.9058	µg
A+1	= max combined front- & back-half blank correction criteria	=	12.46	µg
0.05 x m_{FS}	= 5% of combined front- and back-half sample amount	=	2.3453	µg
MAX	= arithmetic operator that returns the maximum of two values			
MIN	= arithmetic operator that returns the minimum of two values			
$m_{FB-allow}$	= allowable combined Phosphorus blank correction	=	12.4600	µg

NOTE: In this case, the second criteria applies.

3. Combined front- and back-half sample corrected for allowable blank (µg)

$$m_n = m_{FS} - m_{FB-allow}$$

Where:

m_{FS}	= phosphorus amount in combined front- and back-half sample	=	46.9058	µg
$m_{FB-allow}$	= allowable combined phosphorus blank correction	=	12.4600	µg
m_n	= blank-corrected phosphorus in combined sample	=	34.4458	µg

USEPA Method 5/29 (FPM/Metals)
Phosphorus Sample Calculations

Sample data taken from Run 1

Note: The tables presenting the results are generated electronically from raw data. It may not be possible to exactly duplicate these results using a calculator. The reference method data, results, and all calculations are carried to sixteen decimal places throughout. The final table is formatted to an appropriate number of significant figures.

101017 121607
P_M

1. Phosphorus concentration (lb/dscf)

$$C_{sd} = \left(\frac{m_n}{V_{mstd}}\right)\left(\frac{2.205\times10^{-3}}{10^6}\right)$$

Where:

m_n	= phosphorus collected in sample (total µg)	=	34.4458	µg
V_{mstd}	= volume metered, standard (dscf)	=	33.3002	dscf
2.205×10^{-3}	= conversion factor (lb/g)	=	2.205E-03	lb/g
10^6	= conversion factor (µg/g)	=	1.0E+06	µg/g
C_{sd}	= phosphorus concentration (lb/dscf)	=	2.2809E-09	lb/dscf

2. Phosphorus concentration (µg/dscm)

$$C_{sd} = \left(\frac{m_n}{V_{mstd}}\right)(35.31)$$

Where:

m_n	= phosphorus collected in sample (total µg)	=	34.4458	µg
V_{mstd}	= volume metered, standard (dscf)	=	33.3002	dscf
35.31	= conversion factor (dscf/dscm)	=	35.31	dscf/dscm
C_{sd}	= phosphorus concentration (µg/dscm)	=	3.6525E+01	µg/dscm

3. Phosphorus concentration (mg/dscm)

$$C_{sd} = \left(\frac{m_n}{V_{mstd}}\right)\left(\frac{35.31}{1000}\right)$$

Where:

m_n	= phosphorus collected in sample (total µg)	=	34.4458	µg
V_{mstd}	= volume metered, standard (dscf)	=	33.3002	dscf
35.31	= conversion factor (dscf/dscm)	=	35.31	dscf/dscm
1000	= conversion factor (µg/mg)	=	1000	µg/mg
C_{sd}	= phosphorus concentration (mg/dscm)	=	3.6525E-02	mg/dscm

4. Phosphorus concentration (µg/Nm3 dry)

$$C_{sd} = \left(\frac{m_n}{V_{mstd}}\right)(35.31)\left(\frac{68 + 460}{32 + 460}\right)$$

Where:

m_n	= phosphorus collected in sample (total µg)	=	34.4458	µg
V_{mstd}	= volume metered, standard (dscf)	=	33.3002	dscf
35.31	= conversion factor (dscf/dscm)	=	35.31	dscf/dscm
68	= standard temperature (°F)	=	68	°F
32	= normal temperature (°F)	=	32	°F
460	= °F to °R conversion constant	=	460	
C_{sd}	= phosphorus concentration (µg/Nm3 dry)	=	3.9197E+01	µg/Nm^3 dry

5. Phosphorus concentration at actual gas conditions (lb/acf example)

$$C_a = C_{sd}\left(\frac{Q_{std}}{Q_a}\right)$$

Where:

C_{sd}	= phosphorus concentration (lb/dscf)	=	2.2809E-09	lb/dscf
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	=	11,383	dscfm
Q_a	= volumetric flow rate at actual conditions (acfm)	=	13,281	acfm
C_a	= phosphorus concentration at actual gas conditions (lb/acf)	=	1.9550E-09	lb/acf

6. Phosphorus emission rate (lb/hr)

$$E_{lb/hr} = \left(\frac{m_n}{V_{mstd}}\right)\left(\frac{2.205 \times 10^{-3}}{10^6}\right)(Q_{std})(60)$$

Where:

m_n	= phosphorus collected in sample (total µg)	=	34.4458	µg
V_{mstd}	= volume metered, standard (dscf)	=	33.3002	dscf
2.205×10^{-3}	= conversion factor (lb/g)	=	2.205E-03	lb/g
10^6	= conversion factor (µg/g)	=	1.0E+06	µg/g
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	=	11,383	dscfm
60	= conversion factor (min/hr)	=	60	min/hr
$E_{lb/hr}$	= phosphorus emission rate (lb/hr)	=	1.5578E-03	lb/hr

7. Phosphorus emission rate (g/s)

$$E_{g/s} = \left(\frac{m_n}{V_{mstd}}\right)\left(\frac{Q_{std}}{(10^6)(60)}\right)$$

Where:

m_n	= phosphorus collected in sample (total µg)	=	34.4458	µg
V_{mstd}	= volume metered, standard (dscf)	=	33.3002	dscf
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	=	11,383	dscfm
10^6	= conversion factor (µg/g)	=	1.0E+06	µg/g
60	= conversion factor (sec/min)	=	60	sec/min
$E_{g/s}$	= phosphorus emission rate (g/s)	=	1.9625E-04	g/s

8. Phosphorus emission rate - Production-based (lb/unit)

$$E_{RP} = \left(\frac{m_n}{V_{mstd}}\right)\left(\frac{2.205\times10^{-3}}{10^6}\right)\left(\frac{(Q_{std})(60)}{R_p}\right)$$

Where:

m_n	= phosphorus collected in sample (total µg)	=	34.4458	µg
V_{mstd}	= volume metered, standard (dscf)	=	33.3002	dscf
2.205×10^{-3}	= conversion factor (lb/g)	=	2.205E-03	lb/g
10^6	= conversion factor (µg/g)	=	1.0E+06	µg/g
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	=	11,383	dscfm
60	= conversion factor (min/hr)	=	60	min/hr
R_p	= production rate (units/hr)	=	323	units/hour
E_{RP}	= phosphorus emission rate - production-based (lb/xxxxx)	=	#REF!	lb/unit

9. Phosphorus emission rate - Production-based (g/unit)

$$E_{RP} = \left(\frac{m_{CPM}}{V_{mstd}}\right)\left(\frac{(Q_{std})(60)}{(10^6)(R_p)}\right)$$

Where:

m_n	= phosphorus collected in sample (total µg)	=	30.8407	µg
V_{mstd}	= volume metered, standard (dscf)	=	33.3002	dscf
10^6	= conversion factor (µg/g)	=	1.0E+06	µg/g
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	=	11,383	dscfm
60	= conversion factor (min/hr)	=	60	min/hr
R_p	= production rate (units/hr)	=	323	units/hour
E_{RP}	= phosphorus emission rate - production-based (g/xxxxx)	=	#REF!	g/unit

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CEM Field Sample Calculations
for THC Stack Hi Range

Sample data taken from Run 1
and Channel 4

Note: The tables presenting the results are generated electronically from raw data. It may not be possible to exactly duplicate these results using a calculator. The reference method data, results and all calculations are carried to sixteen decimal places throughout. The final table is formatted to an appropriate number of significant figures.

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1. Average of a calibration series

$$C_{mce} = \frac{(C_1 + C_2 + C_3)}{3}$$

Where:

C_1, C_2, C_3	= concentrations of 3 consecutive gas samples that are representative of the calibration gas			
C_{mce}	= average concentration of a calibration series In this case the low cal series for channel 4	=	146.556	ppmwv

2a. Calibration Error Check for Hydrocarbons (5% of actual calibration gas value error allowed by Method 25A)

$$E_{HC} = abs\left|\frac{C_{mce} - C_{ma}}{C_{ma}}\right| \leq l_{cal}$$

Where:

C_{mce}	= average concentration of a calibration series In this case the low cal series for channel 4	=	146.556	ppmwv
C_{ma}	= concentration of actual calibration gas value	=	150.000	ppmwv
l_{cal}	= limit for calibration error for hydrocarbons	=	5.0%	
E_{HC}	= calibration error check value	=	2.30%	**Pass**

2b. Calibration Error Check for non-Hydrocarbons (2% of Instrument Span)

$$E = abs\left|\frac{C_{mce} - C_{ma}}{Span}\right| \leq l_{cal}$$

Where:

C_{mce}	= average concentration of a calibration series In this case the low cal series for channel 4	=	146.556	ppmwv
C_{ma}	= concentration of actual calibration gas value	=	150.000	ppmwv
Span	= instrument span value	=	1000.000	
l_{cal}	= limit for calibration error for non-hydrocarbons	=	2.0%	
E	= calibration error check value	=	NA	

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3. System Bias as Percent of Span Value (5% is allowed)

$$E_{Bias} = abs\left|\frac{C_{mf} - C_{mce}}{Span}\right| \le l_{bias}$$

Where:

C_{mce}	= average concentration of a calibration series in this case the High cal series for channel 4	=	861.562	ppmwv
C_{mf}	= calibration error response concentration for Cal01	=	854.099	ppmwv
Span	= instrument span value	=	1000.000	ppmwv
l_{bias}	= limit for system bias error	=	5.0%	
E_{bias}	= calibration bias error check value	=	0.75%	**Pass**

4. System Drift as Percent of Span Value (3%)

$$E_{Drift} = abs\left|\frac{C_{mf} - C_{mi}}{Span}\right| \le l_{drift}$$

Where:

C_{mf}	= calibration error response concentration for Cal01 (final)	=	854.099	ppmwv
C_{mi}	= calibration error response concentration for Cal00 (initial)	=	861.562	ppmwv
Span	= instrument span value	=	1000.000	ppmwv
l_{drift}	= limit for system drift error	=	3.0%	
E_{drift}	= calibration drift error check value	=	0.75%	**Pass**

5. Average Concentration for an entire Run

$$C = \frac{\sum_{i=1}^{N} C_i}{N}$$

Where:

			i=1	
C_i	= All concentration readings for the entirety of Run 1 for the monitor looking for THC on channel 4	=	0.830	ppmwv
N	= total number of readings in Run 1	=	95	
C	= average THC concentration for Run 1	=	455.716	ppmwv

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6. Drift-Corrected Average Concentration for an entire Run

$$C_{DC} = \left(C - \frac{C_{oi} + C_{of}}{2}\right)\left(\frac{C_{ma}}{\frac{C_{mi} + C_{mf}}{2} - \frac{C_{oi} + C_{of}}{2}}\right)$$

C_{ma}	= concentration of actual calibration gas value	=	861.000	ppmwv
C	= average THC concentration for Run 1	=	455.716	ppmwv
C_{mf}	= calibration error response concentration for Cal01 (final)	=	854.099	ppmwv
C_{mi}	= calibration error response concentration for Cal00 (initial)	=	861.562	ppmwv
C_{of}	= calibration error response concentration for Cal01 (final) for zero gas	=	1.214	ppmwv
C_{oi}	= calibration error response concentration for Cal00 (initial) for zero gas	=	-0.451	ppmwv
C_{DC}	= drift corrected average concentration for Run 1	=	457.221	ppmwv

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CEM Emissions Sample Calculations
for THC Stack Hi Range

Sample data taken from Run 1
and Channel 4

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1. THC concentration (ppmdv)

$$C(ppmdv) = k_1 \times C_{DC} \quad if \quad dry \quad gas$$

$$C(ppmdv) = \frac{k_1 \times C_{DC}}{\left(1 - {B_W}/{100}\right)} \quad if \quad wet \quad gas$$

Where:

C_{DC}	= drift corrected average concentration	=	457.221	ppmwv
B_w	= actual water vapor in gas (% v/v)	=	7.350	% v/v
100	= conversion factor to change percentage to decimal	=	100	
k_1	= ppm/% to ppm conversion factor for diluent gases	=	1	
C (ppmdv)	= THC concentration (ppmdv)	=	493.490	ppmdv

2. THC concentration (ppmwv)

$$C(ppmwv) = k_1 \times C_{DC} \quad if \quad wet \quad gas$$

$$C(ppmwv) = k_1 \times C_{DC} \times \left(1 - {B_W}/{100}\right) \quad if \quad dry \quad gas$$

Where:

C_{DC}	= drift corrected average concentration	=	457.221	ppmwv
B_w	= actual water vapor in gas (% v/v)	=	7.350	% v/v
100	= conversion factor to change percentage to decimal	=	100	
k_1	= ppm/% to ppm conversion factor for diluent gases	=	1	
C (ppmwv)	= THC concentration (ppmwv)	=	457.221	ppmwv

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3. THC concentration (lb/dscf)

$$C(lb/dscf) = \frac{C(ppmdv) \times MW(gas)}{10^6\ ppm \times 385.3}$$

Where:

C (ppmdv)	= THC concentration (ppmdv)	=	493.490	ppmdv
MW	= Molecular Weight of THC gas	=	44.0972	lb/lb-mole
10^6	= conversion factor from decimal to ppm	=	1.00E+06	
385.3	= molar volume	=	385.3	dscf/lb-mole
C (lb/dscf)	= THC concentration (lb/dscf)	=	5.648E-05	lb/dscf

4. THC concentration (lb/scf)

$$C(lb/scf) = C(lb/dscf) \times \frac{Q_{std}}{Q_s}$$

Where:

C (lb/dscf)	= THC concentration (lb/dscf)	=	5.648E-05	lb/dscf
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	=	11383.24205	dscf/min
Q_s	= volumetric flow rate (standard cubic feet/min)	=	12286.23292	scf/min
C (lb/scf)	= THC concentration (lb/scf)	=	5.233E-05	lb/scf

5. THC concentration (lb/acf)

$$C(lb/acf) = C(lb/dscf) \times \frac{Q_{std}}{Q_a}$$

Where:

C (lb/dscf)	= THC concentration (lb/dscf)	=	5.648E-05	lb/dscf
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	=	11383.24205	dscf/min
Q_a	= volumetric flow rate (actual cubic feet/min)	=	13280.59063	acf/min
C (lb/acf)	= THC concentration (lb/acf)	=	4.841E-05	lb/acf

6. THC concentration (%dv)

$$C(\%dv) = C(ppmdv) \times \frac{100}{10^6}$$

Where:

C (ppmdv)	= THC concentration (ppmdv)	=	493.490	ppmdv
100	= conversion factor from decimal to percentage	=	1.00E+02	
10^6	= conversion factor from decimal to ppm	=	1.00E+06	
C (%dv)	= THC concentration (%dv)	=	0.0493%	%dv

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7. THC concentration (mg/dscm)

$$C\left(mg/dscm\right) = C\left(lb/dscf\right) \times k_2 \times 35.31$$

Where:

C (lb/dscf)	= THC concentration (lb/dscf)	=	5.648E-05	lb/dscf
k_2	= conversion factor from lb to mg	=	453515	mg/lb
35.31	= conversion factor from dscf to dscm	=	35.31	ft^3/m^3
C (mg/dscm)	= THC concentration (mg/dscm)	=	904.440	mg/dscm

8. THC concentration (mg/Nm3 dry)

$$C\left(mg/Nm^3\ dry\right) = C\left(lb/dscf\right) \times k_2 \times 35.31 \times \left(\frac{68+460}{32+460}\right)$$

Where:

C (lb/dscf)	= THC concentration (lb/dscf)	=	5.648E-05	lb/dscf
k_2	= conversion factor from lb to mg	=	453515	mg/lb
35.31	= conversion factor from dscf to dscm	=	35.31	ft^3/m^3
68	= standard temperature (°F)	=	68	°F
32	= normal temperature (°F)	=	32	°F
460	= °F to °R conversion constant	=	460	
C (mg/Nm3 dr	= THC concentration (mg/Nm3 dry)	=	970.619	mg/Nm^3 dry

9. THC emission rate (lb/hr)

$$E_{lb/hr} = C\left(lb/dscf\right) \times Q_{std} \times 60$$

Where:

C (lb/dscf)	= THC concentration (lb/dscf)	=	5.648E-05	lb/dscf
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	=	11383.24205	dscfm
60	= conversion factor (min/hr)	=	60	min/hr
$E_{lb/hr}$	= THC emission rate (lb/hr)	=	38.575	lb/hr

10. THC emission rate (kg/hr)

$$E_{kg/hr} = C\left(lb/dscf\right) \times Q_{std} \times 60 \times 0.454$$

Where:

C (lb/dscf)	= THC concentration (lb/dscf)	=	5.648E-05	lb/dscf
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	=	11383.24205	dscfm
60	= conversion factor (min/hr)	=	60	min/hr
0.454	= conversion factor (kg/lb)	=	0.454	kg/lb
$E_{kg/hr}$	= THC emission rate (kg/hr)	=	17.494	kg/hr

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11. THC emission rate (gm/sec)

$$E_{gm/\sec} = C(lb/dscf) \times Q_{std} \times \frac{454}{60}$$

Where:

C (lb/dscf)	= THC concentration (lb/dscf)	=	5.648E-05	lb/dscf
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	=	11383.24205	dscfm
60	= conversion factor (sec/min)	=	60	sec/min
454	= conversion factor (g/lb)	=	453.515	kg/lb
$E_{gm/sec}$	= THC emission rate (gm/sec)	=	4.860	gm/sec

12. THC Fd-based emission rate (ng/J)

$$E_{Fd} = C(lb/dscf) \times (4.54 \times 10^{11}) \times F_d \times (9.486 \times 10^{-10}) \times \left(\frac{20}{20.9} \right.$$

Where:

C (lb/dscf)	= THC concentration (lb/dscf)	=	5.648E-05	lb/dscf
4.54×10^{11}	= conversion factor (ng/lb)	=	4.535E+11	ng/lb
F_d	= ratio of gas volume to heat content of fuel (dscf/MMBtu)	=	0	dscf/MMBtu
9.486×10^{-10}	= conversion factor (MMBtu/J)	=	9.486E-10	MMBtu/J
O_2	= proportion of oxygen in the gas stream by volume (%)	=	20.963	%
20.9	= oxygen content of ambient air (%)	=	20.9	%
E_{Fd}	= THC Fd-based emission rate (ng/J)	=	0.000	ng/J

13. THC production-based emission rate (lb/unit)

$$E_{RP} = C(lb/dscf) \times Q_{std} \times \frac{60}{R_p}$$

Where:

C (lb/dscf)	= THC concentration (lb/dscf)	=	5.648E-05	lb/dscf
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	=	11383.24205	dscfm
60	= conversion factor (min/hr)	=	60	min/hr
R_p	= production rate (units/hr)	=	323.04	units/hour
E_{RP}	= THC production-based emission rate (lb/unit)	=	1.194E-01	lb/unit

14. THC production-based emission rate (kg/unit)

$$E_{RP} = C(lb/dscf) \times 0.454 \times Q_{std} \times \frac{60}{R_p}$$

Where:

C (lb/dscf)	= THC concentration (lb/dscf)	=	5.648E-05	lb/dscf
0.454	= conversion factor (kg/lb)	=	0.454	kg/lb
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	=	11383.24205	dscfm
60	= conversion factor (min/hr)	=	60	min/hr
R_p	= production rate (units/hr)	=	323.04	units/hour
E_{RP}	= THC production-based emission rate (kg/unit)	=	5.416E-02	kg/unit

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USEPA METHOD TO-15 SAMPLE CALCULATIONS - Chlorodifluoromethane Results

Sample data taken from Run 1

Note: The tables presenting the results are generated electronically from raw data. It may not be possible to exactly duplicate these results using a calculator. The reference method data, results and all calculations are carried to sixteen decimal places throughtout. The final table is formatted to an appropriate number of significant figures.

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1. Conversion of as-measured Chlorodifluoromethane concentration to ppm calculation basis

$$C_{s(ppm)} = C_{meas} \times k_1$$

Where:

C_{meas}	= average concentration measured , (ppbdv)	=	3410.0000	ppbdv
k_1	= conversion factor to convert measured concentration to ppm	=	0.0010	
$C_{s\ (ppm)}$	= Chlorodifluoromethane concentration, dry basis (ppmdv)	=	3.4100	ppmdv

2. Chlorodifluoromethane concentration, wet basis (ppmwv)

$$C_{sw(ppm)} = C_{s(ppm)}\left(1 - \frac{B_w}{100}\right)$$

Where:

$C_{s\ (ppm)}$	= Chlorodifluoromethane concentration, dry basis (ppmdv)	=	3.4100	ppmdv
B_w	= actual water vapor in gas (% v/v)	=	7.3496	% v/v
100	= conversion factor (%)	=	100	%
$C_{sw\ (ppm)}$	= Chlorodifluoromethane concentration, wet basis (ppmwv)	=	3.1594	ppmwv

3. Chlorodifluoromethane concentration (lb/dscf)

$$C_{sd\ (lb/dscf)} = \frac{C_{sd\ (ppmdv)} \times MW}{10^6\ ppm \times 385.3}$$

Where:

$C_{sd\ (ppmdv)}$	= average concentration measured using field GC, dry basis	=	3.4100	ppmdv
MW	= molecular weight of Chlorodifluoromethane (g/g-mole)	=	86.470	g/g-mole
385.3	= molar gas volume (dscf/lb-mole)	=	385.3	dscf/lb-mole
$C_{sd\ (lb/dscf)}$	= Chlorodifluoromethane concentration (lb/dscf)	=	7.6528E-07	lb/dscf

4. Chlorodifluoromethane concentration (mg/dscm)

$$C_{sd\,(mg\,/\,dscm\,)} = C_{sd\,(lb\,/\,dscf\,)} \times (453.515)(1000)(35.31)$$

Where:

$C_{sd\,(lb/dscf)}$	= Chlorodifluoromethane concentration (lb/dscf)	=	7.6528E-07	lb/dscf
453.515	= conversion factor (gm/lb)	=	453.515	gm/lb
1000	= conversion factor (mg/gm)	=	1000	mg/gm
35.31	= conversion factor (dscf/dscm)	=	35.31	dscf/dscm
$C_{sd\,(mg/dscm)}$	= Chlorodifluoromethane concentration (mg/dscm)	=	12.2549	mg/dscm

5. Chlorodifluoromethane concentration (mg/Nm3 dry)

$$C_{sd(mg\,/\,Nm^3)} = C_{sd(lb/\,dscf)}(453.415)(1000)(35.31)\left(\frac{68+460}{32+460}\right)$$

Where:

$C_{sd\,(lb/dscf)}$	= Chlorodifluoromethane concentration (lb/dscf)	=	7.6528E-07	lb/dscf
453.515	= conversion factor (gm/lb)	=	453.515	gm/lb
1000	= conversion factor (mg/gm)	=	1000	mg/gm
35.31	= conversion factor (dscf/dscm)	=	35.31	dscf/dscm
68	= standard temperature (°F)	=	68	°F
32	= normal temperature (°F)	=	32	°F
460	= °F to °R conversion constant	=	460	°F
$C_{sd\,(mg/Nm3)}$	= Chlorodifluoromethane concentration (mg/Nm3 dry)	=	10.5041	mg/Nm^3 dry

6. Chlorodifluoromethane concentration at actual gas conditions (lb/acf example)

$$C_a = C_{sd}\left(\frac{Q_{std}}{Q_a}\right)$$

Where:

C_{sd}	= Chlorodifluoromethane concentration (lb/dscf)	=	7.6528E-07	lb/dscf
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	=	11,383	dscfm
Q_a	= volumetric flow rate at actual conditions (acfm)	=	13,281	acfm
C_a	= Chlorodifluoromethane concentration at actual gas conditions (	=	6.5595E-07	lb/acf

7. Chlorodifluoromethane rate (lb/hr)

$$E_{lb\,/\,hr} = C_{sd\,(lb\,/\,dscf\,)} \times Q_{std} \times 60$$

Where:

$C_{sd\,(lb/dscf)}$	= Chlorodifluoromethane concentration (lb/dscf)	=	7.6528E-07	lb/dscf
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	=	11,383	dscfm
60	= conversion factor (min/hr)	=	60	min/hr
$E_{lb/hr}$	= Chlorodifluoromethane rate (lb/hr)	=	0.5227	lb/hr

8. Chlorodifluoromethane rate (kg/hr)

$$E_{kg/hr} = C_{sd(lb/dscf)} \times Q_{sd} \times 60 \times \left(\frac{453.515}{1000}\right)$$

Where:

$C_{sd\ (lb/dscf)}$	= Chlorodifluoromethane concentration (lb/dscf)	=	7.6528E-07	lb/dscf
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	=	11,383	dscfm
60	= conversion factor (min/hr)	=	60	min/hr
453.515	= conversion factor (gm/lb)	=	453.515	gm/lb
1000	= conversion factor (mg/gm)	=	1000	mg/gm
$E_{kg/hr}$	= Chlorodifluoromethane rate (kg/hr)	=	0.2370	kg/hr

#REF! Chlorodifluoromethane rate - Production-based (lb/unit)

$$E_{RP} = C_{sd\ (lb\ /\ dscf\ )} \times \left(\frac{Q_{std} \times 60}{R_p}\right)$$

Where:

$C_{sd\ (lb/dscf)}$	= Chlorodifluoromethane concentration (lb/dscf)	=	7.6528E-07	lb/dscf
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	=	11,383	dscfm
60	= conversion factor (min/hr)	=	60	min/hr
R_p	= production rate (units/hr)	=	323.04	units/hour
E_{RP}	= Chlorodifluoromethane rate - production based(lb/xxxx)	=	1.6180E-03	lb/unit

#REF! Chlorodifluoromethane rate - Production-based (kg/unit)

$$E_{RP} = C_{sd(lb\ /\ dscf)} \times \left(\frac{Q_{std} \times 60 \times 453.515}{1000\ \times R_p}\right)$$

Where:

$C_{sd\ (lb/dscf)}$	= Chlorodifluoromethane concentration (lb/dscf)	=	7.6528E-07	lb/dscf
Q_{std}	= volumetric flow rate at standard conditions, dry basis (dscfm)	=	11,383	dscfm
60	= conversion factor (min/hr)	=	60	min/hr
453.515	= conversion factor (gm/lb)	=	453.515	gm/lb
1000	= conversion factor (mg/gm)	=	1000	mg/gm
R_p	= production rate (units/hr)	=	323.04	units/hour
E_{RP}	= Chlorodifluoromethane rate - production based(kg/xxxx)	=	7.3379E-04	kg/unit

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